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Literature Review

The Effects of Functional Resistance Training & The Role of Perceived Self-Efficacy on Anthropometric Variables & Exercise Adherence in Young Adults

Contents

1.1 - **Abstract**

Functional resistance training (FRT) is a relatively novel approach to resistance training that is becoming increasingly popular within the fitness domain and has been considered to be a better alternative than conventional resistance training (CRT) for improving various measures of muscular and neuromotor fitness. The definitions describing FRT vary to a great extent in the scientific literature, however, the major characteristic of this training method is that it includes movement-based exercises performed in multiple planes of motion which are designed to imitate activities of daily living (ADLs).

Despite the popularity of FRT, most studies on this exercise method have until now mainly been based on anecdotal information from the fitness industry "experts", who have made exaggerated claims about functional exercises and their health benefits. Moreover, because functional training has its origins in physical therapy, the majority of studies have previously focused on older adults and on patients in the rehabilitation process. Therefore, for this reason, there is a scarcity of research studies especially those which include healthy young adults. Consequently, FRT has soared in popularity over the last decade, despite the fact that the research-based evidence is restricted to older people.

1.2 - **Introduction**

Physical exercise plays an important role in both weight management and prevention from chronic and terminal diseases (Chaput et al., 2011). In its position statement in 2011, the American College of Sports Medicine (ACSM), emphasized the numerous health benefits of muscular fitness and the significance of resistance training (RT) in improving this specific fitness component. Both single- and multi-joint exercises can be effectively used in a RT programme for enhancing muscular fitness (ACSM, 2009). Moreover, this could be achieved with a variety of equipment such as free weights, machines, and resistance bands, as well as with the inclusion of different training methods, such as the use of stable and unstable loads (ACSM, 2009).

FRT is a new method of training that is regarded as superior to conventional resistance training for enhancing the muscular and neuromotor fitness components (Weiss et al., 2010). What differentiates FRT from the other RT methods is that it encourages a freedom of movement as it includes multiple-muscle and multiple-joint exercises that simulate movement patterns from daily activities and sports (Lagally, Cordero, Good, Brown, & McCaw, 2009; Weiss et al., 2010; Tomljanovic', Spasic', Gabrilo, Uljevic', & Foretic', 2011, 2011). In addition, according to Thompson (2013), FRT was ranked among the top 10 most popular fitness trends for the current year. However, these results should be interpreted with caution as in this survey the majority of respondents were health fitness professionals and this makes the use of the results difficult when they are examined for their transferability to the general population.

1.3 - **Physical Activity and Young People's Health**

Since ancient times, many physicians have recognized the vital role of physical activity in health maintenance (Lee et al., 2012). In the fifth century BC, the Greek physician Hippocrates indicated that physical exercise when performed according to the people's individual needs, has the potential to invigorate the body, enhance a person's immune system, and delay the aging process (Kokkinos & Myers, 2010).

In the modern era, Morris on the association between vocational physical activity and the prevalence of heart diseases, showed that bus drivers, whose occupation is mainly sedentary were at a higher risk for developing cardiovascular disease in comparison with their more active conductor colleagues (Hallal et al., 2012). Today, it is estimated that the adoption of a sedentary lifestyle has resulted in a substantial increase in non-communicable diseases, such as cardiovascular diseases, diabetes mellitus, and cancers (World Health Organization [WHO], 2010). Recent statistical data show that physical inactivity can induce an increase as large as smoking in global death rates annually (Wen & Wu, 2012). However, the adoption of a more active lifestyle can effectively tackle the ongoing increase in non-communicable diseases and address the problem of overweight and obesity (WHO, 2010). The ACSM (2011) indicated that all healthy adults should participate in at least 150 minutes of moderate, or 75 minutes of vigorous intensity aerobic exercise a week. Moreover, resistance training is a necessary complement to aerobic activity and should be performed with a frequency 2 to 3 times a week along with some neuromotor and flexibility exercises (ACSM, 2011).

1.4 - **Resistance Training and its Beneficial Role on Health**

Resistance training (RT) is an exercise mode commonly used to improve the body composition, muscular and neuromotor fitness (ACSM, 2011; Ciccolo & Kraemer, 2014). A variety of different types of training equipment can be utilized in a typical resistance training programme. More specifically, weight machines, free weights, isokinetic devices, vibration devices, medicine balls, resistance bands, stability balls, sandbags, ropes, and exercises involving one's body weight (Ciccolo & Kraemer, 2014; Anderson & Behm, 2005).

In the past, RT was mainly known as an effective exercise method for enhancing muscular fitness and sports performance in athletic population (Kraemer, Ratamess, & French, 2002). However, until recently little was known of the beneficial health effects of this exercise type (Kraemer et al., 2002). Ciccolo and Kraemer (2014), indicated that numerous health benefits derived from participation in regular RT. More precisely, RT can have positive effects on body composition by inducing increases in lean body mass and decreases in the percentage of body fat. The aforementioned effect on body composition could be useful for preventing obesity, as this could delay the decrease in basal metabolic rate that usually accompanies ageing due to subsequent loss of fat-free mass (Braith &

Stewart, 2006). Moreover, RT has been shown to be protective against the development of coronary heart disease and stroke as it causes modest reductions in both diastolic and systolic blood pressure (Braith & Stewart, 2006; Kraemer et al., 2002).

RT improves insulin sensitivity and glucose metabolism and therefore contributes to the maintenance of normoglycemia in diabetic individuals (Braith & Stewart, 2006; Haskell et al., 2007). Other health benefits of regular RT are the improvement of lipidemic profile, the conservation of bone mass and the amelioration of low back pain (Ciccolo & Kraemer, 2014; Kraemer et al., 2002).

1.5 - **Circuit Training as a Distinctive Resistance Training Method**

Circuit training (CT) as a distinctive training method was first developed in 1953 by Morgan and Adamson who were, both members of staff at the University of Leeds (Sorani, 1966). A typical CT consists of a number of different exercises, usually between 10 and 15, that are carefully selected in order to train each body part (Romero- Arenas, Martínez - Pascual, & Alcaraz, 2013). Each separate exercise used in the circuit is referred to as a station (Sorani, 1966). Usually in each station of the CT individuals must perform approximately 15 repetitions within 40 seconds, while the resistance exercise intensity should not exceed the 60 % of one repetition maximum (Romero- Arenas et al., 2013). One of the main characteristics of the CT is that it consists of lifting lighter weights with relatively brief rest periods between the stations (Braith & Stewart, 2006). In most cases these periods do not exceed the 30 seconds (Romero- Arenas et al., 2013). Because a typical CT consists of at least 10 different exercises and individuals have to perform a high number of repetitions in each of these exercises, with short rest periods between them, this makes this training method suitable for introducing an aerobic component to the workout (Romero- Arenas et al., 2013; Braith & Stewart, 2006). Furthermore, ACSM (2009) found that CT is an effective training method for improving the local muscular endurance, due to its highly continuity and minimal rest between the stations. Therefore, the method of CT consists of a combination of resistance and aerobic exercise training and has a positive affect the muscular and aerobic fitness (Miller et al., 2014; Sorani, 1966).

In addition to this, it has been found that CT is effective for inducing an improvement in body composition (Romero- Arenas et al., 2013). Training programmes that are characterized by high-volume, have short rest periods and include both multi-joint resistance exercises and calisthenics, can be effectively used for body fat reductions (Kraemer et al., 2002; Miller et al., 2014). Another one advantage of CT is that it is time-efficient as it can be fulfilled within 30 minutes (Romero- Arenas et al., 2013). Results of a systematic review showed that time constraint was one of the most important psychological, cognitive and emotional factors that had a negative impact on exercise adherence (Trost, Owen, Bauman, Sallis, & Brown, 2002). Additionally, Murray (2006) indicated that lack of time was the most common barrier to regular physical activity in Scotland. Finally, CT method of fitness training is very convenient as it can be done in a wide variety of places. For instance, exercise rooms, outdoor sports facilities, gymnasiums and even back yards can be effectively used for CT programmes (Sorani, 1966).

1.6 - **Resistance Training using Unstable Surfaces**

Dynamic stability of human locomotion and the ability to maintain balance in upright position is of utmost importance for achieving both optimal performance in the sports and movement efficiency in the activities of daily living (ADLs), such as carrying the shopping bags from the grocery store (Anderson & Behm, 2005). There are many occasions in real-world activities in which force must be exerted when the person performing the task is on an unstable position (Behm & Anderson, 2006). Therefore, for optimizing functional performance, individuals have to exercise on an unstable environment that replicates their real-life situation (Anderson & Behm, 2005).

Based on the concept of training specificity, the human body is designed to adapt to the exercise stimulus created by the workout (ACSM, 2009). As a consequence, an effective exercise protocol should be designed to include training under unstable conditions in order to better prepare the body for the instability that may occur during ADLs, occupation or sport and have some 'carry-over' effect of exercise into a real world setting (Kibele & Behm, 2009). Usually, resistance training on an unstable surface can be achieved through the use of different exercise training modalities such as Swiss balls, BOSU ("both sides up") domes, Dyna-Disks, wobble, rocker and Indo boards, foam rollers as well as with unstable loads, such as partially filled containers of sand or water (Behm & Anderson, 2006; Oliver & Di Brezzo, 2009). Results of studies have shown that instability resistance training induced an increased activation of the participant's trunk musculature

(Behm & Anderson, 2006; Oliver & Di Brezzo, 2009). Furthermore, the trunk stabilizer muscles are even more activated during unstable training when the exercises are performed unilaterally instead of bilaterally, as this results in a greater activation of the contralateral side core stabilizers (Behm & Anderson, 2006). Because many tasks of ADLs and sports movements involve unilateral movement, exercises that result in an increased destabilizing moment arm should be included in the strength training programme (Behm & Anderson, 2006).

Oliver and Di Brezzo (2009) indicated that the effective activation of the core musculature is important for achieving both postural and segmental control. Core stability provides a solid foundation for the torques produced by the upper and lower extremities and it is considered essential for everyday activities, athletic performance and the protection from low back pain (Behm & Anderson, 2006). However, these results do not apply to the case of highly trained individuals, as this segment of the population has already developed an enhanced stability from their previous participation in a ground-based free-weigh exercise programme (Sparks & Behm, 2010). The performance of multijoint exercises such as Olympic-style squats, incorporate a degree of instability. This happens because in the upright position the human body acts as an inverted pendulum and there is a tendency for its center of gravity to sway. During the execution of Olympic squat lifts, this sway is further magnified by the additional disruptive torque of the external load over the center of gravity (Kibele & Behm, 2009). Behm and Anderson (2006) indicated that when an individual performs workout on a stable environment and exerts considerable muscle force in order to complete a set of 3 to 5 repetitions maximum in a multi-joint exercise, this results in a substantial activation of the trunk muscles.

Contrary to the conventional resistance stable training, exercising on an unstable surface can achieve a high level of core muscle activation while using less external resistance due to the greater stabilizing functions and internal muscle tension (Anderson & Behm, 2004; Kibele & Behm, 2009). Moreover, comparing instability resistance training with conventional resistance stable training, it appears that the former is more advantageous as it induces lower torque forces on joints and on the musculotendinous tissue (Sparkes & Behm, 2010). Therefore, exercising on unstable surfaces can be a useful alternative training approach for individuals of the general population, who are primarily interested in health and general fitness conditioning and do not desire to undergo an intensive training programme with high external resistance (Behm & Anderson, 2006).

However, training on unstable surfaces can also have some drawbacks. There is evidence showing that exercise on unstable surfaces can compromise maximal strength and power development as it results in decreased force, power, movement velocity and range of motion (Sparkes & Behm, 2010; Behm, Drinkwater, Willardson, & Cowley, 2010). Therefore, it appears that instability resistance training can be detrimental to absolute gains in muscular strength (Behm & Anderson, 2006; Behm et al., 2010). The aforementioned decline in force output during exercise performed on unstable platforms occurs because of the greater muscle stabilization functions (Anderson & Behm, 2005).

Kornecki, Kebel, and Siemienski (as cited in Anderson & Behm, 2005), indicated that as the contribution of stabilizing muscles was increasing during pushing movements using unstable handles, there was a concurrent reduction in force, velocity and power output. Anderson and Behm (2005) denoted that resistance training using unstable surfaces may be more beneficial to trunk stabilizers than prime movers, as it substantially increases the core muscle activation and only insignificant increase the activity of the muscles that are primarily responsible for producing movement.

Contrary to the abovementioned suggestions, Koshida, Urabe, Miyashita, Iwai, and Kagimori (2008) indicated that the statistically significant, though insignificant decrements in peak muscular outputs under the unstable condition may not compromise the training response. However, the results derived from this study should be interpreted with caution as the participants were confined to male collegiate judo athletes and therefore it is difficult to examine their transferability to female or non- athletic populations.

A study by Weiss et al. (2010) further corroborated the indications of Koshida et al. (2008), after showing that participants performing resistance training on a stability ball slightly increased their bench press strength in comparison with the stable training group.

1.7-**The Effect of Functional Resistance Training on Young Adults Anthropometric Variables**

Functional Resistance Training (FRT) is a distinct training method originally designed as an adjunct to Conventional Resistance Training (CRT) for improving the functional capacity of elderly people and enabling them to perform ADLs without undue fatigue (Fleck, Kraemer, 2014; Pacheco, Teixeira, Franchini, & Takito, 2013). As a consequence, there is a lack of research on the young adult population (Weiss et al., 2010; Tomljanovic' et al., 2011).

In 2010, a study performed by Weiss et al. examined the effects of FRT and CRT on a number of anthropometric and performance measurements of thirty-eight young adults. At the end of the 7-week intervention period, researchers inferred that there were no significant differences between the two training groups. However, the main differences between them was a larger forearm circumference in the CRT group, and a greater flexion test time in the FRT group. Concerning the effects on the other anthropometric variables, researchers reported a significant increase in body weight, as well as in bicep and calf circumferences in the CRT group. Correspondingly, the FRT group showed a significant increase in shoulder girth. Finally, both of these exercise protocols failed to induce a statistically significant reduction in the body mass index (BMI) and waist circumference of participants.

Recent research by Tomljanovic' et al. (2011) examined the effect of FRT and CRT on anthropometric and motor performance variables of twenty three moderately trained male athletes. The study lasted for 5 weeks and consisted of 3 training sessions per week. After the end of the study, results showed that neither of the two exercise protocols had a significant effect on the anthropometric measurements of participants. Researchers claimed that the relatively short duration of the study probably was the main reason for not observing a significant change in the anthropometric data of participants and they attributed this to the limitations of their study.

In the two aforementioned studies, participants were randomly allocated into one of the two training groups, the FRT and the CRT group. Kang, Ragan, and Park (2008) indicated that randomization of the sample size in a study is of utmost importance in order to eliminate selection bias and control for potential confounding variables that could lead to inaccurate results. However, it is also worth mentioning that both studies had a common methodological flaw that could have compromised the validity of their results. More specifically, neither Weiss et al. (2010) nor Tomljanovic' et al. (2011) informed their participants to keep a food diary during the study period. A possible consumption of energy dense foods in one of the two groups could have distorted the final results. Another study that examined the effect of diet and exercise interventions on anthropometric variables in overweight and obese participants, included a daily record of food intake during the period of weight loss (Foster-Schubert et al., 2012).

1.8 - **Clarifying Differences Between Functional and Conventional Resistance Training**

FRT is a relatively new method of training that has gained substantial popularity in the fitness market in the last decade (Weiss et al., 2010; Tomljanovic' et al., 2011; Thompson, 2013). FRT has its origins in rehabilitation and was first used by physical and occupational therapists (Fleck & Kraemer, 2014). The definitions describing FRT can cause confusion in the field as vary to a great extent in the scientific literature. Nonetheless, the major characteristic of this training method is that it includes multiple joint and multiple planar exercises that replicate ADLs and movement patterns from sports (Lagally et al., 2009; Weiss et al., 2010; Tomljanovic' et al., 2011). In order to improve functional fitness, a well-designed exercise programme should include resistance training to enhance an individual's muscular and neuromotor fitness components, such as balance, coordination, power, force and endurance (ACSM, 2011; Thompson, 2013). This is considered necessary for improving functional performance of daily activities, such as lifting bags from the ground and being able to rising from a chair (Fleck & Kraemer, 2014; Thompson, 2013).

The major difference between a FRT protocol and the other exercise regimens is that the former emphasizes on specific exercises that enhance the performance of movement, instead of focusing on individual muscle groups (Brill, 2008). By utilizing more of the body in each movement individuals are perceived to be more competent when they need to perform their daily tasks, such as gardening, laundry, and climbing ladders (Brill, 2008). Therefore, the word "functional" is related to the performance of a movement, work or activity (Weiss et al., 2010). Tomljanovic' et al. (2011) indicated that the concept of FRT is mainly based on the SAID principle. SAID acronym stands for Specific Adaptation to Imposed Demands and is one of the training principles of resistance training (Clark, Lucett, & Kirkendall, 2010). According to this training principle, the human body will undergo specific adaptations to the specific training stimulus placed upon it (Clark, et al., 2010). Therefore, in order to make training adaptations more transferable, the exercises of a FRT protocol need to be designed in such a way that they can replicate the specific movements of an individual's daily life, occupation or sport (Tomljanovic' et al., 2011; Weiss et al., 2010). According to Shaikh and Mondal (2012), in order to be effective and produce adequate results, a FRT programme need to stimulate the central nervous system. The optimal functioning of the neuromuscular system is of utmost importance to prepare the body for everyday challenges such as stability, balance, flexing, rotating and lifting (Shaikh and Mondal, 2012). In other words, a FRT protocol should include multi-muscle exercises that focus on multiple movement planes and performed on both stable and unstable surfaces (Weiss et al., 2010; Tomljanovic' et al., 2011).

Contrary to FRT, CRT emphasize on specific muscle groups in order to enhance their muscular fitness, such as their muscle strength and endurance, without concerning about training movements that are connected to ADLs (Weiss et al., 2010; Tomljanovic' et al., 2011).

CRT is based on weight-machine and free weight exercise protocols that are performed on stable surfaces and limit their movement to the sagittal plane of motion (Weiss et al., 2010; Tomljanovic' et al., 2011). Because CRT includes single-joint exercises that are confined to one plane of motion, this results in poorer carry-over effects to real world activities that require three-dimensional movement and the use of more than one muscle groups at the time to complete the daily tasks (Weiss et al., 2010; Brill, 2008).

1.9-**Rating of Perceived Exertion and OMNI-Resistance Exercise Scale for Resistance Training**

The rating of perceived exertion (RPE) was first used for assessing the intensity during aerobic exercise, including cyclic movement activities, such as running and bicycling (Naclerio et al., 2011). More recently, RPE has also been effectively used as a tool for measuring the intensity of resistance exercise in a wide variety of healthy participants (Naclerio et al., 2011; Morishita, Yamauchi, Fujisawa, & Domen, 2013).

RPE can be used for the quantification of resistance exercise intensity, because of its interrelation with physiological markers of exercise stress, such as blood lactate levels and skeletal muscle electromyographic activity (Lis-Filho et al., 2012). Another advantage of this method, is that RPE can determine the intensity of resistance exercise without the need of carrying out maximal and submaximal strength tests (Lis-Filho et al., 2012). This could be useful for novice weightlifters, as it has been reported that maximal strength testing put them at a higher risk of injury (Dohoney, Chromiak, Lemire, Abadie, & Kovacs, 2002). However, some external environmental factors such as, temperature can affect the accuracy of RPE results. Glass, Knowlton, and Becque (1994) indicated that the use of

RPE to monitor exercise intensity under conditions of high ambient temperature may not be a reliable indicator.

Morishita et al. (2013) stated that a number of different RPE scales have been used for the evaluation of perceived exertion during resistance training. One of them is the OMNI-resistance exercise scale (OMNI-RES). OMNI-RES was developed by Robertson et al., as a substitute for Borg's RPE scale (Naclerio et al., 2011; Morishita et al., 2013). The OMNI-RES has both verbal and pictorial descriptors that are distributed along the 10-point response scale (Robertson et al., 2003). The link among the picture, the numerical and the verbal reference, has been shown to enhance the reliability of the OMNI-RES to quantify the intensity of resistance exercise. The above-mentioned characteristics of the OMNI-scale make it superior to other similar scales as it is a practically convenient tool for fitness professionals and can be applied in physical activity settings (Naclerio et al., 2011).

Robertson et al. (2003) established the concurrent validation of the OMNI-RES using total weight lifted and blood lactate concentration as criterion variables. The results of this study showed that both male and female weight lifters demonstrated positive linear regression coefficients between the two criterion variables and the RPE for active muscle and overall body when they performed upper and lower body resistance training at an intensity of 65% of the one-repetition maximum (1-RM). Additionally, Colado et al. (2012) concurrent validated the OMNI-RES for resistance band training. In this study researchers used heart rate and myoelectric activity as criterion variables. However, it is worth mentioning that in both cases the OMNI-RES was validated while participants performed only single joint exercises, consequently it remains unknown as to whether similar results would have occurred if participants had performed multi-joint movements.

1.10- **Self-Efficacy as a Psychological Determinant of Exercise Adherence**

The construct of perceived self-efficacy represents one important aspect of social cognitive theory and pertains to a person's belief in his or her ability to achieve the desired result in a highly specific task (Bandura, 1997). Bandura (1986) emphasizes that self-efficacy is domain specific rather than being a generalized perception of abilities. Therefore, an individual's high self-efficacy in a specific domain does not guarantee high self-efficacy in another area. Self-beliefs of efficacy can play a pivotal role in people's choices, their goals, how much effort they expend on a particular activity, the degree of perseverance they demonstrate in the face of an adversity and how much stress and depression they experience in coping with taxing environmental demands (Bandura, 1991). Bandura (1997) indicates that self-efficacy beliefs contribute to subsequent behaviour in a variety of different areas of functioning, such as educational, health, clinical, athletic, organizational and collective.

In the fitness domain, the concept of self-efficacy is very important, since it can be used as a tool for developing effective interventions to increase physical activity levels and decrease the dropout rates (Jackson, 2010). A large body of evidence suggests that self-efficacy predicts physical activity behaviour and exercise adherence in healthy adults

(Trost et al., 2002; Rovniak, Anderson, Winett, Stephens, 2002; Kaewthummanukul & Brown, 2006; Sharma, Sargent, & Stacy, 2005; Strachan, Woodgate, Brawley, & Tse, 2005). Understanding the determinants of physical activity is necessary for the adoption of an active lifestyle (Colella, Morano, Bortoli, & Robazza, 2008). Therefore, it is reasonable to expect that exercise programmes may benefit from incorporating social cognitive theory modifications and assessing self-efficacy as a component in determining behavioural change (Cataldo, John, Chandran, Pati, & Shroyer, 2013).

1.11- **Review of Self-Efficacy Scales Designed to Regulate Exercise**

Sallis, Pinski, Grossman, Patterson, and Nader (1988) developed a self-efficacy scale for health-related exercise behaviours. A provisional 12-item self-efficacy scale was designed and administered to 171 participants. All the items' responses were along a 5-point scale from "I could not do it" to "Sure I could do it. Principal-component analysis with varimax rotation was carried out to identify the factor structure of the scale. It encompassed two factors: resisting relapse and making time for exercise. The alpha coefficients were 0.83 and 0.85 for the exercise self-efficacy factors. However, the test-retest reliabilities for the factors were not satisfactory, as were both 0.68.

Rudolph and McAuley (1996) administered a 8-item exercise self-efficacy scale to fifty undergraduate males in order to examine their belief in their abilities to complete consecutive 10-minute blocks of treadmill running at a moderately fast tempo. Participants' self-efficacy was measured on a 100-point percentage scale with 10 point increments, from 10% "highly uncertain" to 100% score "completely certain". Exercise self-efficacy scores were obtained from the mean of the 8-item scores. The internal consistency of this scale was greater than 0.95 and the results derived from the study were in accordance with Bandura's theoretical construct of self-efficacy, as there was a negative correlation between participants' level of self-efficacy and their perceptions of effort during exercise time. Participants with higher self-efficacy reported lower perceptions of physical exertion. Nonetheless, the sample size was small and was restricted to male participants.

De Bourdeaudhuij, Sallis, and Vandelanotte (2002) conducted a 7-year longitudinal study employing a 11-item self-efficacy scale to track a group of young adults. At the baseline there were 980 respondents, while seven years later only 172 respondents were left for the data analysis. In order to take the self-efficacy measurements, respondents were asked to determine their confidence in their ability to maintain exercise under adverse conditions. Self-efficacy was assessed by the sum of the 11-items that were scored on a 3-point Likert scale. The alpha coefficients of this scale were between 0.88 and 0.91. Finally, the results of this study showed that there was a positive correlation between self-efficacy and exercise maintenance.

Ryckman, Robbins, Thornton, and Cantrell (1982) developed the Physical Self-Efficacy (PSE) scale. At the time, there was no suitable psychometrically valid tool for measuring self-efficacy in the sport and activity domain. Therefore, PSE scale was the first that examined the realm of self-efficacy and exercise. The PSE scale consists of a 10-item Perceived Physical Ability (PPA) subscale, and a 12-item Physical Self-Presentation Confidence (PSPC) subscale. The former subscale assess perceived physical ability with regards to specific attributes, such as speed, agility and strength, whereas the latter subscale evaluates confidence in the social display of physical skills. All the items are responded along a 6-point continuum from strongly agree to strongly disagree. Higher scores on the PPA and the PSPC subscales reflecting a stronger PSE. Ryckman et al. (1982) tested the PSE-scale in six different studies and found the test-retest and alpha reliabilities to be highly satisfactory with an alpha 0.81. Additionally, the PSE scale has been found to be applicable to different training situations and it can be used both in sport-specific settings as well as in other situations involving the use of general physical skills (Malherbe, Steel, & Theron, 2003; Duncan & McAley, 1987; Williams & Cash, 2001; Thornton, Ryckman, Robbins, Donolli, & Biser, 1987).

However, Bandura (1997) criticized the PSE scale as an inappropriate measure of self-efficacy because it is an all-purpose measure of perceived self-efficacy and therefore it violates the basic assumption of the multidimensionality of self-efficacy beliefs.

1.12- **Conclusion**

The reported high energy expenditure during FRT programmes (Lagally et al., 2009; Panza et al., 2014) in combination with the time efficiency of this training method when it is performed in a circuit (Lagally et al., 2009), can rationalize its worldwide popularity during the last 8 consecutive years (Thompson, 2013). Because time constraints are a characteristic of our era and have been shown to be correlated with physical activity behaviour (Trost et al., 2002; Murray, 2006; Cerin, Leslie, Sugiyama, & Owen, 2010; Grave, Calugi, Centis, El Ghoch, & Marchesini, 2011), short duration workouts that result in high energy expenditure would be useful in today's fitness industry. However, although FRT has soared in popularity over the last years (Thompson, 2013; Weiss et al., 2010), there is still a shortage of scientific studies examining the effects of this training method in young people (Lagally et al., 2009; Weiss et al., 2010; Tomljanovic et al., 2011).

As previously demonstrated, studies conducted with young participants failed to induce any significant difference in their BMI, waist circumference, and body composition measurements (Weiss et al., 2010; Tomljanovic et al., 2011). A summary of relevant literature related to the effect of FRT on anthropometric variables in healthy young adults can be observed in Appendix 1.

However, in these studies, researchers neglected to inform their participants to keep a food diary during the intervention period. It is assumed that this methodological deficiency could have distorted the results of these studies, as researchers could not assess the effect of participants' dietary patterns on their anthropometric measurements.

On the other hand, the role of perceived self-efficacy in exercise adherence is another important factor that should to be taken into consideration when designing exercise programmes. Exercise professionals should use the construct of perceived self-efficacy when their priority is to design effective interventions and to increase exercise participation and adherence in the adult population. A systematic review of Trost et al. (2002) demonstrated that perceived self-efficacy of individuals is one of the most important factors of exercise adherence and physical activity behaviour.

1.13- **Rationale for Further Research**

Undoubtedly, FRT is a novel training method that is gaining popularity in the fitness industry (Weiss et al., 2010). As was demonstrated by the results of a recent global study, FRT is among the top 10 fitness trends for this year (Thompson, 2013). It is noteworthy to mention that the vast majority of people, who participated in this survey where young adults, between 22 and 34 years of age. These figures show that FRT is popular in the younger age groups. However, because the majority of respondents in this survey were health fitness professionals, these results should be viewed with caution.

There is however much scientific evidence to support the role of perceived self-efficacy in promoting physical activity in adults (Trost et al., 2002). It appears that no other study has examined the relationship between FRT and self-efficacy in young adults. Moreover, there is limited research examining the effects of this method in young people. Therefore, further research is warranted to examine the effect of FRT on anthropometric variables and self-efficacy in young population.

Appendix 1- Previous Studies Examined the Effects of Functional & Conventional Exercise Protocols on Anthropometric Variables in Young Adults

Studies	Subjects	Functional Exercise(FE) Protocol	Conventional Exercise(CE) Protocol	Methodology	Results	Conclusion	Limitations
Weiss et al. (2010) University of Wisconsin-Eau Clair, USA	n= 38 Male and female participants that were familiar with resistance training (18-32 yr)	Multi-joint, multi-planar movement exercises, performed with free weight and free-motion cable column	Single & multi-joint exercises performed with free weight and machine modalities. Exercises executed in sagittal plane of motion	Moderate intensity, 2 sets of 10 repetitions in each of the 11 exercises. Exercise 3 days/week for a total of 7 weeks	FE Group Increased shoulder girth CE Group: Increased body weight, and bicep, forearm and calf girths	Comparing the CE and FE protocols, subjects participating in the CE protocol significantly increased their forearm girth	Inter-tester variability & use of RPE to estimate exercise intensity
Tomljanovic et al. (2011) University of Split, Croatia	n=23 Male participants moderately trained athletes (22-25 yr)	Movement-based, trunk stabilization exercises, performed on an unstable surface	Multi & single joint exercises performed with free weights on a stable environment	80% of 1 RM, 4 sets of 6 to 10 repetitions in each of the 8 exercises of the FE and CE protocols. Exercise 3 days/week for 5 weeks	No significant overall effects reported	Neither the FE nor the CE protocol induced significant changes in anthropometric variables of participants	5-week intervention period insufficient to change anthropometric measurements

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Research Paper

Effects of Functional Vs. Conventional Circuit Training on Anthropometric Variables and Physical Self-Efficacy of Young Adults

Contents

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Rationale for Journal Publication

A potential journal for publication of this study would be The Journal of Exercise Science and Fitness (JESF), a peer reviewed journal that publishes original investigations on contemporary topics in Exercise Science. The current study is related to Exercise Science as it compares the effects of two different training protocols on body composition and on self-efficacy of university students. Moreover, according to the guidelines for authors, the structure of the article resemble that of dissertation writing guidelines. Consequently, this dissertation can easily be adjusted to meet the requirements of the journal. The five-year Impact Factor of JESF is 0.84 and a literature search showed that a similar study to the present research has recently been published in this journal. Consequently, the JESF appears a possible choice for future publication.

Abstract

Background: Functional resistance training (FRT) is an exercise method originally designed to assist frail elderly people to perform their activities of daily living (ADLs). Nevertheless, during the last years FRT has increased in popularity among young adults who are in pursuit of improving their physique. FRT differentiates from conventional resistance training (CRT) as it includes multijoint and multiplanar exercises.

Purpose: To evaluate the effects of a functional circuit training (FCT) and a conventional circuit training (CCT) programme on anthropometric variables and physical self-efficacy (PSE) of young adults.

Methods: Fifteen adults, eight females and seven males, aged from 18 to 34 years, were randomly assigned to a FCT and a CCT group. Anthropometric and PSE measurements were taken at baseline and at the end of the 6-week intervention period.

Results: There were no significant differences between the two training groups, as well as between the pre- and post-intervention measurements for the anthropometric variables (body weight, body composition measurements) and PSE scores. Significant differences were observed between the two time points in waist circumferences (WC). However, a significant effect of the exercise programme on WC values was not observed.

Conclusions: Except WC values both exercise programmes did not change participants anthropometric variables and PSE scores. No difference between the exercise groups was observed on their effect on participants' anthropometric measurements and PSE scores.

Introduction

The popularity of FRT is increasing in the fitness industry and nowadays FRT is regarded as more efficient than CRT for enhancing musculoskeletal and neuromotor fitness (Weiss et al., 2010). The rationale behind the FRT is that ADLs, such as climbing the ladder, require a concurrent movement of upper and lower extremities rather than restricting motion to a single body part (Brill, 2008).

Shaikh and Mondal (2012) suggested that FRT should induce a high degree of central nervous system stimulation in order to enhance whole body movement and prepare it for real-world challenges, including postural stability and rotational movements. Therefore, contrary to CRT, FRT comprises of multi-joint and multi-planar exercises that replicate movement tasks of everyday life (Lagally, Cordero, Good, Brown, & McCaw, 2009; Weiss et al., 2010). Moreover, because FRT induces adaptations that are transferable to real-world setting, it could positively affect compliance with exercise programmes (Weiss et al., 2010).

However, despite the increasing popularity of FRT, until now there is lack of scientific evidence concerning the effect of this novel form of exercise on anthropometric variables in healthy, physically active, young adults (Tomljanovic', Spasic', Gabrilo, Uljevic', & Foretic', 2011).

A systematic review by Trost, Owen, Bauman, Sallis, and Brown (2002) showed that perceived self-efficacy of individuals was one of the most important determinants of exercise adherence and physical activity behaviour. There is a large body of evidence showing the positive effect of aerobic exercise on a person's self-efficacy. On the other hand, only a few studies were conducted to identify the effects of resistance training on this psychological construct (Martin, 2006).

Due to the fact that further investigation is warranted to examine the effects of FRT in young people (Weiss et al., 2010), and the need to study the effect of different exercise methods on the individual's self-efficacy (Martin, 2006), the purpose of the present study was two-fold: first, to compare the effects of a Functional Circuit Training (FCT) programme with a Conventional Circuit Training (CCT) programme on anthropometric variables in young adults; and second, to examine the effects of the same exercise programmes on the participants' self-efficacy. We hypothesized that participation in the FCT group would produce stronger effects on anthropometric variables and physical self-efficacy of participants than observed in the CCT group.

Methods

Participants

Eight females and seven males, aged 18-34 agreed to participate in the study. They were recruited from the university campus and the surrounding region. A variety of different dissemination strategies were used for raising awareness of the study. More precisely, a coloured poster (A2 sized) was displayed on the university's Fitness Centre notice board (Appendix 1). In addition, a letter of invitation was sent electronically to the students university email addresses (Appendix 2). The other participants were recruited through word-of-mouth. Participants received a participant information form explaining the procedures that will encounter during the research period, as well as the risks and the benefits of the study (Appendix 3). According to the participation requirements, participants should had at least six months of resistance training experience, but should not have previously participated in any structured FRT programme. All participants received and completed an informed consent and health screen form (Appendix 4; Appendix 5). They self-reported they were free of any pathological or other condition that could prevent them from participating in the study. Participants reported that they were using performance-enhancing substances were excluded from the study. This study included only those participants that participated in at least 14 of the total 18 training sessions. The study received ethical approval from the University Research Ethics Committee (Appendix 6).

Experimental Design of the Study

Fifteen females and males were randomly allocated to either a Functional Circuit Training (FCT) or a Conventional Circuit Training (CCT) group. Before the start of the study and after the end of the 6-week intervention period, anthropometric and physical self-efficacy measurements were taken and recorded in specially designed forms (Appendix 7; Appendix 8). The week preceding the start of the research was used to familiarize participants with the exercise protocols. More specifically, each individual participated in a one-on-one exercise training session in the university's Fitness Centre with the researcher. During these sessions, the researcher conducted a pilot study to confirm that the OMNI-Resistance Exercise Scales (OMNI-RES) (Appendix 9; Appendix 10) could be applied in the exercise room and ensured that all participants could properly perform the exercises. Finally, in an attempt to control potential confounding variables, during the 6-week intervention period participants were told to keep a food and a physical activity diary for the purpose of recording on a daily basis their dietary patterns as well as their habitual physical activity (Appendix 11; Appendix 12).

Anthropometric Measurements

Anthopometric measurements of body height (BH), body weight (BW) and waist circumference (WC) were taken for each participant according to the guidelines of the National Health and Nutrition Examination Survey protocol (NHANES, 2007). BH measurements were taken using the Seca Leicester stadiometer, in centimeters (cm), with the participant standing barefoot and the head aligned in the Frankfort horizontal plane. BW was measured using the Tanita BC-534 InnerScan body composition monitor in kilograms (kg), while the participants were dressed in light clothing. The body mass index (BMI) values derived from the BW and BH measurements using the BMI formula (Centers for Disease Control and Prevention, 2014).

WC is considered to be a clinically-acceptable measure of abdominal fat and is a better alternative than BMI for assessing cardiometabolic risk in apparently healthy adults (Brenner, Tepylo, Eny, Cahill, & El-Sohemy, 2010; Behan & Mbizo, 2007). WC was measured to the nearest 0.1 cm with a Gulick tape and taken just above the right ilium in the midaxillary line. The tape was parallel to the floor and snug but did not compress the skin. A Gulick tape measure was used in this study because it has been shown to reduce skin compression and therefore improving consistency of WC measurements (American College of Sports Medicine, 2014).

Assessment of Body Composition

Participants were assessed for body composition via bioelectrical impedance analysis. The Bodystat 1500 (Bodystat Ltd, Douglas, Isle of Man, UK) was used to measure body fat percentage (BF%), fat mass (kg), lean body mass percentage (LBM%) and LBM (kg). In order to receive accurate results from the body composition measurements, participants were given instructions to abstain from participating in any kind of strenuous exercise and avoid consuming alcohol and caffeinated beverages 12 hours before testing.

Furthermore, they were asked to fast at least 4 hours before arriving at the laboratory. These guidelines were in accordance with these of Meeuwsen, Horgan, and Elia (2010), who used the same bioelectrical impedance analyzer to take measurements from a large sample size of UK adults (n=23627). Nevertheless, participants in the present study were allowed to consume a light snack 2 hours before testing.

Instrumentation

In the current study the Physical Self-Efficacy (PSE) Scale was employed for data collection (Appendix 8). PSE scale was developed by Ryckman, Robbins, Thornton and Cantrell, (1982) and includes two subscales, the 10-item Perceived Physical Ability (PPA) and the 12-item Physical Self-Presentation Confidence (PSPC). PSE scale is regarded as a holistic approach to assess self-efficacy and can be used within the physical activity domain due to its ability to be generalized to exercise (Colella, Morano, Bortoli, & Robazza, 2008). PSE scale was selected for this study because two studies similar to the present research had used this psychometric tool (Williams & Cash, 2001; Martin, 2006). Finally, all the anthropometric and self-efficacy measurements were taken at the university's laboratory.

Exercise Protocols

Both the FCT and the CCT programmes included a 10-minute warm-up and cool-down at the start and the end of each exercise session respectively. The exercises included in the FCT and CCT programmes were performed in a circuit and each circuit comprised of 10 different exercises (stations). Circuits were repeated twice with 2 minutes rest between them. Time allocated for each station was approximately one minute and during this period participants had to perform 15 repetitions with a moderate tempo (1-2 seconds concentric contraction, 1 second isometric contraction, 1-2 seconds eccentric contraction). All the repetitions were performed at an intensity 6 "somewhat hard" based on the OMNI-RES (Robertson et al., 2003; Colado et al., 2012). Following each exercise of the sequence, the researcher displayed the OMNI-RES Scale (Appendix 9; Appendix 10) in front of participants and asked them to identify their rating of perceived exertion (RPE). Based on participants RPE researcher adjusted the exercise load in order to maintain the RPE 6 over a 6-week period. Contrary to CCT, in the FCT programme apart from manipulating the external weight, the exercise intensity was adjusted by altering the moment arm of resistance and the surface stability (Ratamess, 2012). Brief rest periods of 30 seconds were interspersed between the stations in order to allow participants to move from one station to the next. In 2007, Westcott et al., designed a similar circuit workout protocol to improve physical fitness of military personnel. However, the rest time differed from that of the present study. The total exercise time was approximately 50 minutes and the frequency of the workouts was 3 times a week.

All the exercise sessions were performed under the close supervision of the researcher and took place at the university's Fitness Centre. Before the start of the first workout a circuit training layout sheet was distributed to participants of both exercise groups, so as to know the order of exercises for each programme (Appendix 13; Appendix 14).

Functional Circuit Training (FCT)

The FCT programme consisted of multiple-joint and multiple-planar movements performed on stable and unstable surfaces and using free weights, resistance bands, medicine balls, stability balls, BOSU (both sides up) domes, exercise mats and TRX Suspension Trainer. The exercises were performed on both stable and unstable surfaces. All the exercises of the FCT programme are depicted in Figure 1.

 Back extension with rear deltoid raise	 Dumbbell chest press on the stability ball	 TRX single arm rotation pull	 Resistance band punch on a BOSU
 Medicine ball sit-up	 Squat with bicep curl	 Plank with leg abduction	
 Static lunge with tricep extension	 Russian twists with a medicine ball	 Squat with lateral deltoid raise	

Fig. 1 Functional Circuit Training Exercises

Conventional Circuit Training (CCT)

The CCT programme consisted of single and multi-joint exercises, performed on one plane of motion and using free-weights, weight machines (Cybex Eagle), cable machines (Cybex FT 360; Cybex Cable Column), exercise mats, and medicine balls. The exercises were performed in a stable environment. All the exercises of the CCT programme are depicted in Figure 2.

Fig. 2 Conventional Circuit Training Exercises

To control for potential confounding factors, a qualitative analysis of participants' nutritional habits and additional physical activity was conducted. For tracking dietary patterns in participants, all foods that were high in fat, sugar and salt were grouped into the category of "Junk Food" (Smith et al., 2009; Arya & Mishra, 2013). Thereafter, the consumption frequency of "Junk Food" during the 6-week intervention period was estimated (Appendix 15). Three participants (ID 2 in week 1, ID 8 and ID 10 in week 6) were outliers (ID 2: value 3 , ID 8: value 1, ID 10: value 3). This occurred because during these weeks they completed a 2- or 4-day food record instead of a 7-day. A qualitative analysis of participants' additional physical activity was carried out based on the mean values of seven days intensity of activity (Appendix 16). Finally, the results from the qualitative data analysis showed that post intervention anthropometric measurements were neither confounded by participants' dietary patterns nor by additional activity during the study period.

Statistics and Methods

Sample size calculations were made with G*Power 3.1.9 statistical software. Input parameters for a statistical test “ANOVA repeated measures within-between interaction”, were: effect size f=0.3, a=0.05, power=0.8, number of groups=2, number of measurements=2, correlation among repeated measure=0.5 and non sphericity correction=1 (Heinrich-Heine-Universität Düsseldorf, 2013). A total sample size of 24 individuals was calculated but due to study restrictions, fifteen young adults finally participated.

Randomization in two exercise groups (FCT, CCT) was applied by generating seven sets of numbers with 2 numbers per set, number range from 1 to 2, retaining each number in set unique (Urbaniak & Plous, 2008). In this way, 14 participants were randomly allocated to exercise groups, whereas the last one was allocated to functional group.

Data are expressed as Mean±SD or median with a range when noted. A value of $p<0.05$ was considered statistically significant. A mixed model ANOVA repeated measurements was used to test differences in mean dependents’ values between the two exercise groups (FCT, CCT) across time (at two time points) and Independent Samples t-tests, were applied to detect the direction of significant differences (Field, 2009).

Results

The study sample consisted of 15 adults (8 female (53,3%) and 7 male (46,7%) aged from 18 to 34 years (Mean±SD: 23,6±4,5 years old). Seven participants (46,7%) followed the CCT whereas the rest eight (53,3%) the FCT. Measurements were taken before beginning the study ("before" measurement) and at the end of the study ("after" measurement) for 13 participants (86,7%), as two (13,3%) were dropouts (the "after" measurement was missing).

Variables Age (in years), Height (in meters), Weight (in Kilograms), Body Mass Index (BMI)(Kg/m^2), Body Fat (BF)(%), Body Fat (BF)(Kg), Lean Body Mass (LBM)(%), Lean Body Mass (LBM)(Kg), and Waist Circumference (WC)(cm) are ratio measurement scales, as they satisfy the characteristics of the real number series: Order, distance and origin (Smith & Albaum, 2013). To test the normality of the distribution of these values, the Shapiro-Wilk was used because the sample size was less than 100 (Coakes & Steed, 2007) (Table 1).

Table 1: Tests of normality for the variables Age (y), Height (m), BMI (Kg/m^2), Body Fat (%), Body Fat (Kg), Lean Body Mass (%), Lean Body Mass (Kg), and Waist Circumference (cm).

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Height	0,177	13	,200*	0,936	13	0,403
age	0,119	13	,200*	0,954	13	0,658
Weight (before)	0,124	13	,200*	0,967	13	0,859
Weight (after)	0,117	13	,200*	0,975	13	0,947
BMI (%) (before)	0,153	13	,200*	0,92	13	0,251
BMI (%) (after)	0,187	13	,200*	0,919	13	0,241
Body Fat (%) (before)	0,187	13	,200*	0,925	13	0,289
Body Fat (%) (after)	0,225	13	0,07	0,901	13	0,137
Lean Body Mass (%) (before)	0,187	13	,200*	0,924	13	0,286
Lean Body Mass (%) (after)	0,222	13	0,08	0,897	13	0,12
Body Fat (Kg) (before)	0,262	13	0,015	0,784	13	0,004
Body Fat (Kg) (after)	0,256	13	0,02	0,798	13	0,006
Lean Body Mass (Kg) (before)	0,239	13	0,041	0,897	13	0,122
Lean Body Mass (Kg) (after)	0,228	13	0,062	0,906	13	0,161
Waist Circumferance (cm) (before)	0,11	13	,200*	0,978	13	0,968
Waist Circumferance (cm) (after)	0,157	13	,200*	0,966	13	0,847

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

As in Table 1 is presented, all variables are normally distributed (The null hypothesis: Data are normally distributed is not rejected, as p-value>0.05) except from the case of Body Fat (Kg) (p-value is equal to 0.004<0.05 and 0.006 for “before” and “after” measurements respectively). Based on the above results, in the cases where normality is not violated, values are presented as Mean±SD, whereas for non-normal values the “median” and “range” are used (Table 2) (McCluskey & Lalkhen, 2007).

Table 2: Descriptive statistics for ratio variables Weight (Kg), BMI (Kg/m^2), Body Fat (%), Body Fat (Kg), Lean Body Mass (%), Lean Body Mass (Kg), and Waist Circumference (cm), by group of exercise.

	Type of excercise	Mean*	SD**	N
Weight (before)	conventional	78,6	19,4	6
	functional	69,4	11,4	7
	Total	73,6	15,7	13
Weight (after)	conventional	78,4	19,9	6
	functional	70	11,6	7
	Total	73,9	15,9	13
BMI (%) (before)	conventional	25,8	5,4	6
	functional	23,2	2,2	7
	Total	24,4	4,1	13
BMI (%) (after)	conventional	25,8	5,6	6
	functional	23,4	2,3	7
	Total	24,5	4,2	13
Body Fat (%) (before)	conventional	24	9,1	6
	functional	21,3	7,5	7
	Total	22,5	8,1	13
Body Fat (%) (after)	conventional	23,4	8,6	6
	functional	21	7	7
	Total	22,1	7,5	13
Lean Body Mass (%) (before)	conventional	76	9,1	6
	functional	78,7	7,5	7
	Total	77,5	8,1	13
Lean Body Mass (%) (after)	conventional	76,8	8,6	6
	functional	79	7	7
	Total	78	7,5	13
Body Fat (Kg) (before)	conventional	17	10,4-43,1)	6
	functional	14,8	(5,7-21,9)	7
	Total			13
Body Fat (Kg) (after)	conventional	15,8	(9-41,4)	6
	functional	13,2	(7,2-22,8)	7
	Total			13
Lean Body Mass (Kg) (before)	conventional	59	13,5	6
	functional	54,6	10,7	7
	Total	56,7	11,8	13
Lean Body Mass (Kg) (after)	conventional	59,4	13,6	6
	functional	55,3	10,4	7
	Total	57,2	11,6	13
Waist Circumferance (cm) (before)	conventional	84,8	13,1	6
	functional	79,3	8,8	7
	Total	81,8	10,9	13
Waist Circumferance (cm) (after)	conventional	83,5	12,2	6
	functional	76,9	8,1	7
	Total	79,9	10,3	13

*In case of Body Fat(Kg), median value is presented due to variables non normal distribution (McCluskey & Lalkhen, 2007)
**In case of Body Fat (Kg), the range of data is presented due to variables non normal distribution (McCluskey & Lalkhen, 2007)

There is an ongoing debate in the scientific community whether Likert scales should be treated as ordinal or interval level of data (Curado, Teles, & Maroco, 2014). In this study, data from the Physical Self-Efficacy (PSE) scale was considered as an ordinal scale of measurement, because the response categories used in this scale have a rank order but the space between values cannot be assumed equal (Curado et al., 2014). PSE scale consisting of the Perceived Physical Ability (PPA) and the Physical Self-Presentation Confidence (PSPC) subscales (Ryckman et al., 1982). PPA subscale had a median sum of 38 (with a minimum value 21 and a maximum 50) before the exercise and a median value of 41 after the exercise (range from 32 to 50). PSPC subscale had a median value 52 before and after the exercise but in the first case with a range from 41 to 62 whereas in the second with a range of 42 to 65. The overall PSE scale had a median value of 95 before the application of exercise (any group) with a minimum of 63 and a maximum of 108, and after the exercise a median of 96 (from 82 to 104).

To test differences in mean dependents' values between the two exercise groups (FCT, CCT) across time(at two time points), seven different mixed models were applied as many as the dependent variables were (Weight (Kg), BMI (Kg/m^2), Body Fat (%), Body Fat (Kg), Lean Body Mass (%), Lean Body Mass (Kg), and Waist Circumference (cm)) (Field, 2009).

Before running the analysis, the distribution of these variables was examined for normality (at each group) and the homogeneity of variance was tested (Field, 2009).

Samples were assumed to be randomly located. The normality of each group of the dependent variables was presented in Table 1 and test of homogeneity of variance is depicted in Table 3. The assumption of homogeneity is met, as null hypothesis is not rejected (all p-values in Table 3 are higher than 0.05 ranging from 0.184 to 0.880).

Table 3: Test of Homogeneity of Variances, for ratio variables between exercise groups.

Levene's Test of Equality of Error Variances [a]

	F	df1	df2	Sig.
Weight (before)	2,010	1	11	,184
Weight (after)	1,896	1	11	,196
BMI (%) (before)	1,814	1	11	,205
BMI (%) (after)	1,924	1	11	,193
Body Fat (%) (before)	,024	1	11	,878
Body Fat (%) (after)	,132	1	11	,723
Lean Body Mass (%) (before)	,024	1	11	,880
Lean Body Mass (%) (after)	,081	1	11	,781
Body Fat (Kg) (before)	1,037	1	11	,330
Body Fat (Kg) (after)	,843	1	11	,378
Lean Body Mass (Kg) (before)	,084	1	11	,778
Lean Body Mass (Kg) (after)	,345	1	11	,569
Waist Circumferance (cm) (before)	,408	1	11	,536
Waist Circumferance (cm) (after)	,282	1	11	,606

After meeting the assumptions, seven different mixed models ANOVA were run. The results are presented in Tables 4(a)-10(b).

Table 4(a): Tests of within –subjects contrasts for a mixed model ANOVA, with dependent variable “Weight (Kg)”.

Tests of Within-Subjects Contrasts

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Linear	,400	1	,400	,949	,351
time * group	Linear	,863	1	,863	2,047	,180
Error(time)	Linear	4,638	11	,422		

Table 4(b): Tests of between –subjects effects for a mixed model ANOVA, with dependent variable "Weight (Kg)".

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	141859,326	1	141859,326	285,536	,000
group	501,872	1	501,872	1,010	,336
Error	5464,993	11	496,818		

Table 5(a): Tests of within –subjects contrasts for a mixed model ANOVA, with dependent variable "BMI (%)".

Tests of Within-Subjects Contrasts						
Measure: MEASURE_1						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Linear	,045	1	,045	1,185	,300
time * group	Linear	,088	1	,088	2,322	,156
Error(time)	Linear	,417	11	,038		

Table 5(b): Tests of between –subjects effects for a mixed model ANOVA, with dependent variable "BMI (%)".

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	15547,341	1	15547,341	465,256	,000
group	39,772	1	39,772	1,190	,299
Error	367,584	11	33,417		

Table 6(a): Tests of within –subjects contrasts for a mixed model ANOVA, with dependent variable "Body Fat (%)".

Tests of Within-Subjects Contrasts						
Measure: MEASURE_1						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Linear	1,213	1	1,213	1,115	,314
time * group	Linear	,115	1	,115	,106	,751
Error(time)	Linear	11,967	11	1,088		

Table 6(b): Tests of between –subjects effects for a mixed model ANOVA, with dependent variable "Body Fat (%)".

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	12978,217	1	12978,217	101,395	,000
group	40,925	1	40,925	,320	,583
Error	1407,957	11	127,996		

Table 7(a): Tests of within –subjects contrasts for a mixed model ANOVA, with dependent variable "Lean Body Mass (%)".

Tests of Within-Subjects Contrasts						
Measure: MEASURE_1						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Linear	1,717	1	1,717	1,815	,205
time * group	Linear	,262	1	,262	,276	,609
Error(time)	Linear	10,408	11	,946		

Table 7(b): Tests of between –subjects effects for a mixed model ANOVA, with dependent variable "Lean Body Mass (%)".

Tests of Between-Subjects Effects

Measure: MEASURE_1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	155737,246	1	155737,246	1215,965	,000
group	39,277	1	39,277	,307	,591
Error	1408,848	11	128,077		

Table 8(a): Tests of within –subjects contrasts for a mixed model ANOVA, with dependent variable "Body Fat (Kg)".

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Linear	,396	1	,396	,627	,445
time * group	Linear	,310	1	,310	,490	,498
Error(time)	Linear	6,954	11	,632		

Table 8(b): Tests of between –subjects effects for a mixed model ANOVA, with dependent variable "Body Fat (Kg)".

Tests of Between-Subjects Effects

Measure: MEASURE_1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	7468,492	1	7468,492	47,809	,000
group	134,892	1	134,892	,863	,373
Error	1718,384	11	156,217		

Table 9(a): Tests of within –subjects contrasts for a mixed model ANOVA, with dependent variable "Lean Body Mass (Kg)".

Tests of Within-Subjects Contrasts						
Measure: MEASURE_1						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Linear	1,592	1	1,592	3,307	,096
time * group	Linear	,139	1	,139	,288	,602
Error(time)	Linear	5,296	11	,481		

Table 9(b): Tests of between –subjects effects for a mixed model ANOVA, with dependent variable "Lean Body Mass (Kg)".

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	84228,654	1	84228,654	293,046	,000
group	116,385	1	116,385	,405	,538
Error	3161,671	11	287,425		

Table 10(a): Tests of within –subjects contrasts for a mixed model ANOVA, with dependent variable "Waist Circumference (cm)".

Tests of Within-Subjects Contrasts						
Measure: MEASURE_1						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Linear	22,861	1	22,861	7,501	,019
time * group	Linear	1,938	1	1,938	,636	,442
Error(time)	Linear	33,524	11	3,048		

Table 10(b): Tests of between –subjects effects for a mixed model ANOVA, with dependent variable "Waist Circumference (cm)".

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	170075,443	1	170075,443	771,446	,000
group	240,059	1	240,059	1,089	,319
Error	2425,095	11	220,463		

No significant effect of training groups was observed across time for dependent variables Weight (Kg), BMI (Kg/m^2), Body Fat (%), Body Fat (Kg), Lean Body Mass (%), Lean Body Mass (Kg) (p-values>0.05 in Tables 4 (a)-9(b)).

However, the test of within-subjects effects in Table 10(a) indicated that there is a significant effect of time on "Waist Circumference" ($p=0.019<0.05$) meaning that there is a statistically significant difference in the Waist Circumference between the two time points of measurements of participants: at the beginning and at the end of the study (for both exercise groups). The lack of an interaction between "time" and "exercise group" indicates that this effect is consistent for both exercise groups. In order to identify if these differences exist between the FCT and CCT groups, Independent sample t-tests were applied by using Bonferroni adjustment, to decrease the possibility of conducting type I error. In this case, the new critical value is 0.05/2=0.025 as 2 comparison tests are conducted (Bland & Altman, 1995).

Table 11: Independent samples t test to compare means of Waist Circumference (before, after) between the two exercise groups.

Independent Samples Test

		Equality of Variances		t-test for Equality of Means					Interval of the	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Waist Circumferance (cm) (before)	Equal variances assumed	,227	,641	1,359	13	,197	7,321	5,389	-4,320	18,963
	Equal variances not assumed			1,328	10,739	,212	7,321	5,515	-4,853	19,495
Waist Circumferance (cm) (after)	Equal variances assumed	,282	,606	1,177	11	,264	6,643	5,645	-5,781	19,067
	Equal variances not assumed			1,139	8,473	,286	6,643	5,833	-6,678	19,964

Looking at the p-values for equal variance assumed (Table 11), they are all higher than the new significance level thus no significance difference in Waist Circumference between the two exercise groups exist.

The test of between-subjects effects (Table 10b) indicates there is not a significant effect of the type of exercise on “Waist circumference (cm)”. The profile plot, clearly displays the main effects and the absence of an interaction (Figure 1).

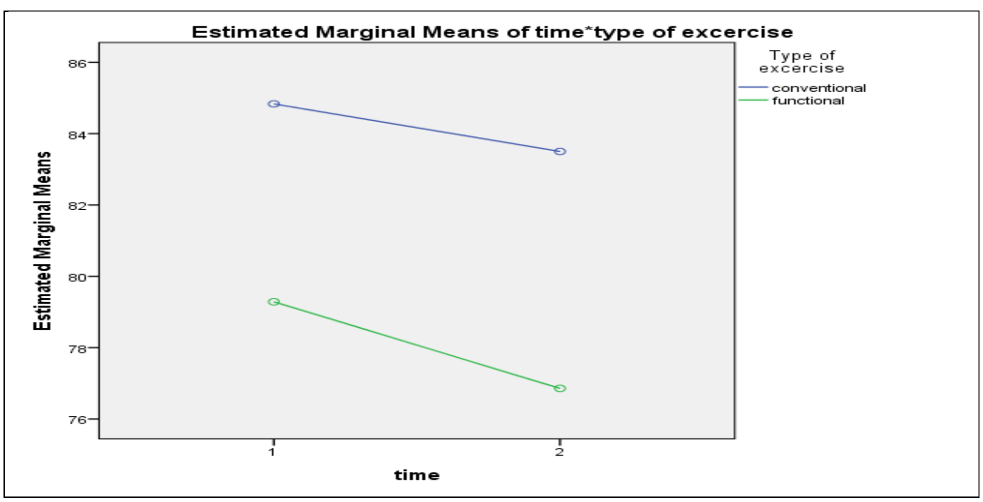

Figure 1: Mean values of “Waist circumference (cm)” for each type of exercise, adjusted for time.

In Figure 2 the significant difference in “Waist circumference (cm)” between the two time points is depicted and specifically values are significantly lower at the second measurement (end of study) (Mean ±SD: 79,9±10,3 cm) versus the first measurement (at the beginning) (Mean ±SD: 81,7±10,7 cm).

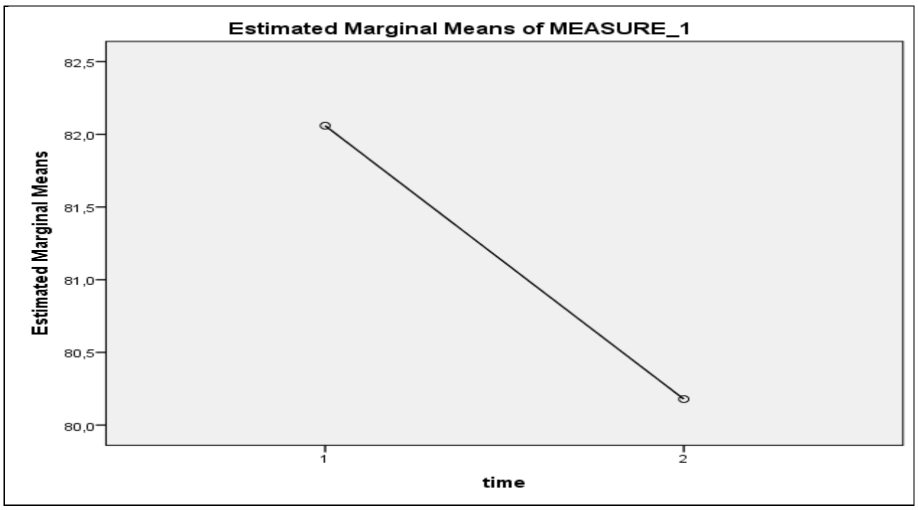

Figure 2: Mean values of "waist circumference (cm)” for each time point.

Discussion

The purpose of this research was to examine the effect of two different exercise programmes (FCT and CCT) on a number of anthropometric variables and on physical self-efficacy (PSE) of young adults. The research hypothesis that the FCT programme would have a greater impact on the anthropometric variables was not supported by the results of this study. Current data showed that participation in a 6-week FCT and CCT programme apart from the changes in waist circumference (WC) measurements, did not induce significant changes in all the other anthropometric variables.

The most important finding of this research was that both exercise programmes (FCT and CCT) induced a significant decrease in WC in young adults. Previous literature support the results of the present study. Azizi and Baledi (2012) found that CCT performed at the same intensity and frequency with that of our study, led to significant decreases in WC measurements, in healthy overweight women. However, after conducting an extensive literature review on this topic, it could not be found other studies showing that FCT significantly reduced WC in participants. It appeared that this is the first study to demonstrate a beneficial effect of FCT on WC in this population group. A previous study, that used similar exercise protocols to the present study, failed to find significant reductions in WC in young adults (Weiss et al., 2010). However, different WC measurement protocols were used in these studies. Weiss et al. (2010) measured WC at the umbilical level, whereas in the current study the measurements were taken just above the right ilium (NHANES, 2007). Apart from NHANES, the National Institutes of

Health (NIH) also recommends that the superior border of the iliac crest should be used as an anatomical site for the WC measurements (Bosy-Westphal et al., 2010). Although there is no consensus on the optimal protocol for WC measurement (Mason & Katzmarzyk, 2009), in this study we applied the NHANES protocol because it uses internal (bony) landmarks which contrary to external landmarks (umbilicus) are stable sites and not affected by weight changes (Mason & Katzmarzyk, 2009; Cornier et al., 2011). Mason and Katzmarzyk (2009) indicated that the superiority of any protocol for measuring WC is defined from the reproducibility of its results. Therefore, the fact that previous studies that examined the effectiveness of four WC sites demonstrated that WC measured just above the iliac crest was the most reliable indicator of total adiposity (Wang et al., 2003), while umbilicus was the least reproducible anatomic landmark (Mason & Katzmarzyk, 2009), could explain the different results in WC measurements between Weiss et al. (2010) and these of the present study.

Concerning the results of the other anthropometric variables (body weight, body composition measurements) these are in accordance with findings from a similar study on Croatian kinesiology students. More precisely, Tomljanovic' et al. (2011) reported that the functional and traditional training groups did not change significantly their anthropometric variables (body weight, body composition measurements) after 5 weeks of training. However, contrary to the above-mentioned findings, Weiss et al. (2010) observed a significant increase in body weight in the traditional training group, following 7 weeks of exercise.

Lagally et al. (2009) undertook a study to investigate the metabolic response to a continuous FCT programme in young adults. In this study researchers used the same method for measuring exercise intensity (OMNI-RES), same intensity level (RPE 6) and a similar exercise protocol with that used in this study. Following the end of the data collection session, researchers found that the mean energy expenditures in minutes for both male and female participants were higher than the energy expenditure reported in studies examining CCT. Researchers attributed the higher energy cost to the large amount of muscle mass involved in the functional exercise movements. Furthermore, another study by Panza et al. (2014) found that bench press performed on an unstable surface at the same load percentage used on a stable surface induced significantly higher energy expenditure. Consequently, the fact that in this study the FCT programme produced the same effect with the CCT programme on the anthropometric measurements, do not seem logical.

The hypothesis that FCT would enhance the PSE of participants to a greater degree than CCT cannot be supported by the current data. Neither FCT nor CCT changed significantly the score of PSE scale after 6 weeks of training. These results are not consistent with previous findings of similar studies. More specifically, Williams and Cash (2001) showed a significant increase in young adults PSE after having participated in a 6-week CCT programme. Another study by Martin (2006) examined the role of three exercise protocols (aerobic, resistance, combination) on PSE of female participants. After the 3-week intervention period participants of all groups improved their PSE.

However, special consideration should be given to the study's limitations before extrapolating the results to a larger population. First, the present study was carried out on a restricted sample of young adults (n=15). Second, potential confounding variables of diet and physical activity were controlled based on qualitative analysis from the diaries data. However, Driskell and Wolinsky (2011) indicated that diaries are subjected to substantial error because individuals are likely to misreport their energy intake. Therefore, future research should examine the effects of FCT on body composition of young adults while using unbiased biomarkers of energy intake, such as doubly-labeled water (Subar et al., 2003). Finally, for perceived self-efficacy, the PSE scale may not be an appropriate measure as it is a holistic approach to assess self-efficacy and this violates the basic assumption of the multidimensionality of self-efficacy beliefs (Bandura (1997). Future research is needed to assess the impact of FCT on perceived self-efficacy using domain-linked measure of the self-efficacy construct.

Conclusion

In summary, the results of the current study suggest that neither the FCT nor the CCT programme induced significant changes in participants body weight, body composition variables and PSE. However, both exercise protocols (FCT and CCT) significantly decreased participants WC after 6 weeks of training.

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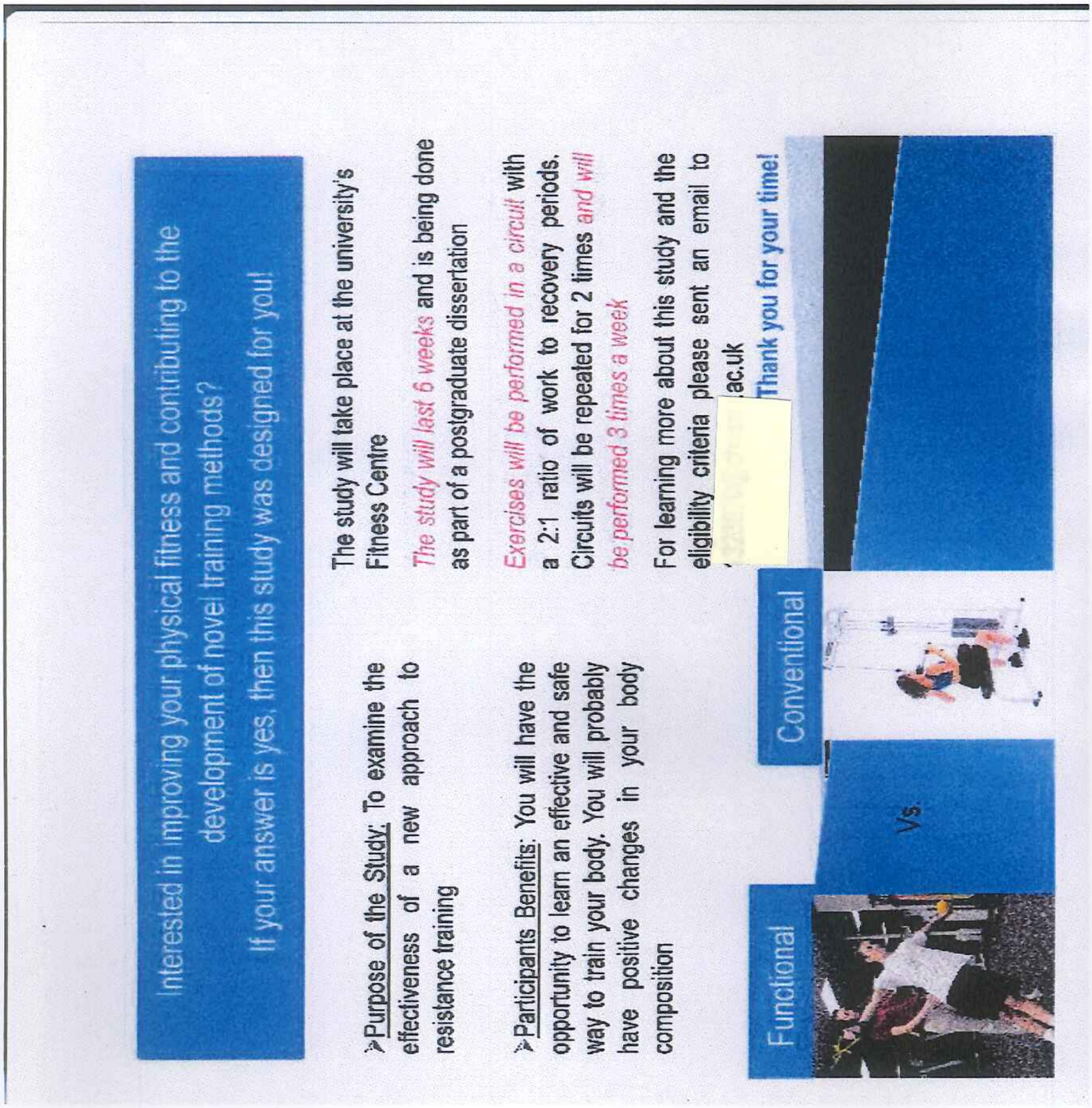
Appendices

Appendix 1 - Poster



Appendix 2 - Letter of Invitation

Hello,

My name is George Kostakis and I am a postgraduate student from Greece. As a part of my dissertation for the MSc in Exercise and Nutrition Science, I am currently conducting research that focuses on a comparison between a Functional and a Conventional Resistance Training. For this reason I have designed 2 different exercise protocols and I am looking for participants to run this project. Exercises will be performed in a circuit with a 2:1 ratio of work to recovery periods. Circuits will be repeated for 2 times and will be performed 3 times a week for 6 weeks. Anthropometric measurements (height, weight, waist circumference and body composition) will be collected pre- and post-intervention. The level of physical self efficacy will be assessed through a Likert scale questionnaire. The testing sessions will last approximately one hour. All the18 training sessions will take place in the facilities of the university's Fitness Centre.

If you have any further questions, please feel free to contact me at:

Kind Regards,

George

Appendix 3 - Participant Information Sheet

Participant information sheet

Effects of Functional Vs. Conventional Circuit Training on Anthropometric Variables and Physical Self-Efficacy of University Students

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?

The purpose of this study is to examine the effectiveness of the novel training method of Functional Resistance Training compared to Conventional Resistance Training in a sample of healthy young adults. Functional Resistance Training includes multiple joint and multiple planar exercises that replicate activities in daily life. Conventional Resistance Training includes exercises that are executed in weight machines and isolate individual muscle groups.

Why have I been chosen?

You have been chosen because you are a healthy young adult, you have at least 6 months prior experience of resistance training, but have not participated in any structured functional training programme.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect you in any way.

What will happen to me if I take part?

Before the start of the study, you will participate in one familiarization session. During this session you will have the opportunity to learn the proper technique of each of the exercises included in the exercise protocol. Following this session, you will participate in a 6-week exercise programme. You will be randomly allocated to a functional or a conventional circuit training group.

The training sessions will be performed with a frequency of 3 times a week and each session will last approximately one hour. Each of the two circuits will include 10 different exercises. Each exercise will last 60 seconds and will be followed by a rest period of 30 seconds. The intensity of the workout will be 6 (somewhat hard), based on the rating of perceived exertion (RPE) of OMNI scale. It is required from you to participate in at least 14 of the total 18 training sessions. Anthropometric (height, weight, waist circumference, and body composition) and physical self-efficacy measurements will be collected pre- and post-intervention. You will be required to abstain from participating in any strenuous physical activity and alcohol/caffeine consumption 12 hours before testing. Your last meal 2 hours before testing should be limited to a light snack and 0.5 litres of water. During the 6-week intervention period it is important to maintain your usual dietary patterns and physical activity levels.

What are the possible disadvantages and risks of taking part?

Although, the study has been designed in order to maximize the safety of the participants, there is a possibility to experience muscle soreness.

What are the possible benefits of taking part?

By taking part, you will be contributing to the development of novel training methods for more effective and enjoyable workouts.

What if something goes wrong?

If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of the Faculty of Life Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, 01244 513055.

Will my taking part in the study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential so that only the researcher carrying out the research will have access to such information.

What will happen to the results of the research study?

The results will be written up into a report for the final project of my MSc. Individuals who participate will not be identified in any subsequent report or publication.

Who is organising the research?

The research is conducted as part of a MSc in Exercise & Nutrition Science within the Department of Clinical Sciences and Nutrition at the University of Chester. The study is organised with supervision from the department, by George Kostakis, an MSc student.

Who may I contact for further information?

If you would like more information about the research before you decide whether or not you would be willing to take part, please contact:

George Kostakis:

Thank you for your interest in this research.

Appendix 4 - Informed Consent Form

University of Chester

QUI DOCET IN DOCTRINA

Title of Project: Effects of Functional Vs. Conventional Circuit Training on Anthropometric Variables and Physical Self-Efficacy of University Students

Name of Researcher: George Kostakis

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected. ☐

3. I agree to take part in the above study. ☐

_____________________ ___________________ ______________

Name of Participant Date Signature

___________________________ ________________ __________________

Researcher Date Signature

1 for participant; 1 for researcher

Appendix 5 - Pre-test Health Screening Questionnaire

Pre-test Questionnaire

Effects of Functional Vs. Conventional Circuit Training on Anthropometric Variables and Physical Self-Efficacy of University Students

Researcher *: George Kostakis*

Name:__________________________________ Test date:________________

Contact number:_____________________________ Date of birth:___________

In order to ensure that this study is as safe and accurate as possible, it is important that each potential participant is screened for any factors that may influence the study. Please circle your answer to the following questions:

1. Has your doctor ever said that you have a heart condition *and* that you should only perform physical activity recommended by a doctor? YES/NO

2. Do you feel pain in the chest when you perform physical activity? YES/NO

3. In the past month, have you had chest pain when you were not performing physical activity? YES/NO

4. Do you lose your balance because of dizziness *or* do you ever lose consciousness? YES/NO

5. Do you have bone or joint problems (e.g. back, knee or hip) that could be made worse by a change in your physical activity? YES/NO

6. Is your doctor currently prescribing drugs for your blood pressure or heart condition? YES/NO

7. Are you pregnant, or have you been pregnant in the last six months? YES/NO

8. Have you injured your hip, knee or ankle joint in the last six months? YES/NO

9. Do you know of any other reason why you should not participate in physical activity? YES/NO

Thank you for taking your time to fill in this form. If you have answered ‘yes’ to any of the above questions, unfortunately you will not be able to participate in this study.

Appendix 6 - Faculty of Research Ethics Committee Ethical Approval

University of Chester

Faculty of Life Sciences

Research Ethics Committee

frec@chester.ac.uk

Dear George,

Study title:	**Effects of Functional Vs. Conventional Circuit Training on Anthropometric Variables and Physical Self-efficacy of University Students.**
FREC reference:	**893/14/GK/CSN**
Version number:	**1**

Thank you for providing the documentation for the amendments recommended following the approval of the above application. These amendments have been approved by the Faculty Research Ethics Committee.

With the Committee's best wishes for the success of this project.

Yours sincerely,

Appendix 7 - Anthropometric and Body Composition Measurements Form

Exercise Group

Functional Circuit Training ☐

Conventional Circuit Training ☐

Demographic Questions

What is your name? ....

What is your age? ....years old

What is your gender? ....

Anthropometric / Body Composition Data

Variables	Pre-Exercise Measurements	Post-Exercise Measurements
Body Height (meters)		
Body Weight (kilograms)		
Body Mass Index (BMI)		
Percentage of Body Fat (%)		
Percentage of Lean Body Mass (%)		
Body Fat (kilograms)		
Lean Body Mass (kilograms)		
Waist Circumference (centimeters)		

Appendix 8 - Physical Self-Efficacy Scale

Directions: Below is a number of statements, which people have used to describe themselves. Please read each statement and yellow mark the answers. Use the Text Highlight Color button of Microsoft Word to mark the number in each question. Marking "1" indicates that you agree strongly with the aforementioned statement, marking "6" indicates that you disagree strongly with the aforementioned statement. Please record the time taken to answer questions. Thank you for taking the time to complete this questionnaire.

Physical Self-Efficacy (PSE) Scale

Perceived Physical Ability (PPA) Subscale

1. I have excellent reflexes

6 5 4 3 2 1

Strongly agree strongly disagree

2. I am not agile and graceful

1 2 3 4 5 6

Strongly agree strongly disagree

3. My physique is rather strong

6 5 4 3 2 1

Strongly agree strongly disagree

4. I can't run fast

1 2 3 4 5 6

Strongly agree strongly disagree

5. I don't feel in control when I take tests involving physical dexterity

1 2 3 4 5 6

Strongly agree strongly disagree

6. I have poor muscle tone

1 2 3 4 5 6

Strongly agree strongly disagree

7. I take little pride in my ability in sports

1 2 3 4 5 6

Strongly agree strongly disagree

8. My speed has helped me out of some tight spots

6 5 4 3 2 1

Strongly agree strongly disagree

9. I have a strong grip

6 5 4 3 2 1

Strongly agree strongly disagree

10. Because of my agility, I have been able to do things which many others could not do

6 5 4 3 2 1

Strongly agree strongly disagree

Physical Self-Presentation Confidence (PSPC) Subscale

1. I am rarely embarrassed by my voice

6 5 4 3 2 1

Strongly agree strongly disagree

2. Sometimes I don't hold up well under stress

1 2 3 4 5 6

Strongly agree strongly disagree

3. I have physical defects that sometimes bother me

1 2 3 4 5 6

Strongly agree strongly disagree

4. I am never intimidated by the thought of a sexual encounter

6 5 4 3 2 1

Strongly agree strongly disagree

5. People think negative things about me because of my posture

1 2 3 4 5 6

Strongly agree strongly disagree

6. I am not hesitant about disagreeing with people bigger than me

6 5 4 3 2 1

Strongly agree strongly disagree

7. Athletic people usually do not receive more attention than me

6 5 4 3 2 1

Strongly agree strongly disagree

8. I am sometimes envious of those better looking than myself

1 2 3 4 5 6

Strongly agree strongly disagree

9. Sometimes my laugh embarrasses me

1 2 3 4 5 6

Strongly agree strongly disagree

10. I am not concerned with the impression my physique makes on others

6 5 4 3 2 1

Strongly agree strongly disagree

11. Sometimes I feel uncomfortable shaking hands because my hands are clammy

1 2 3 4 5 6

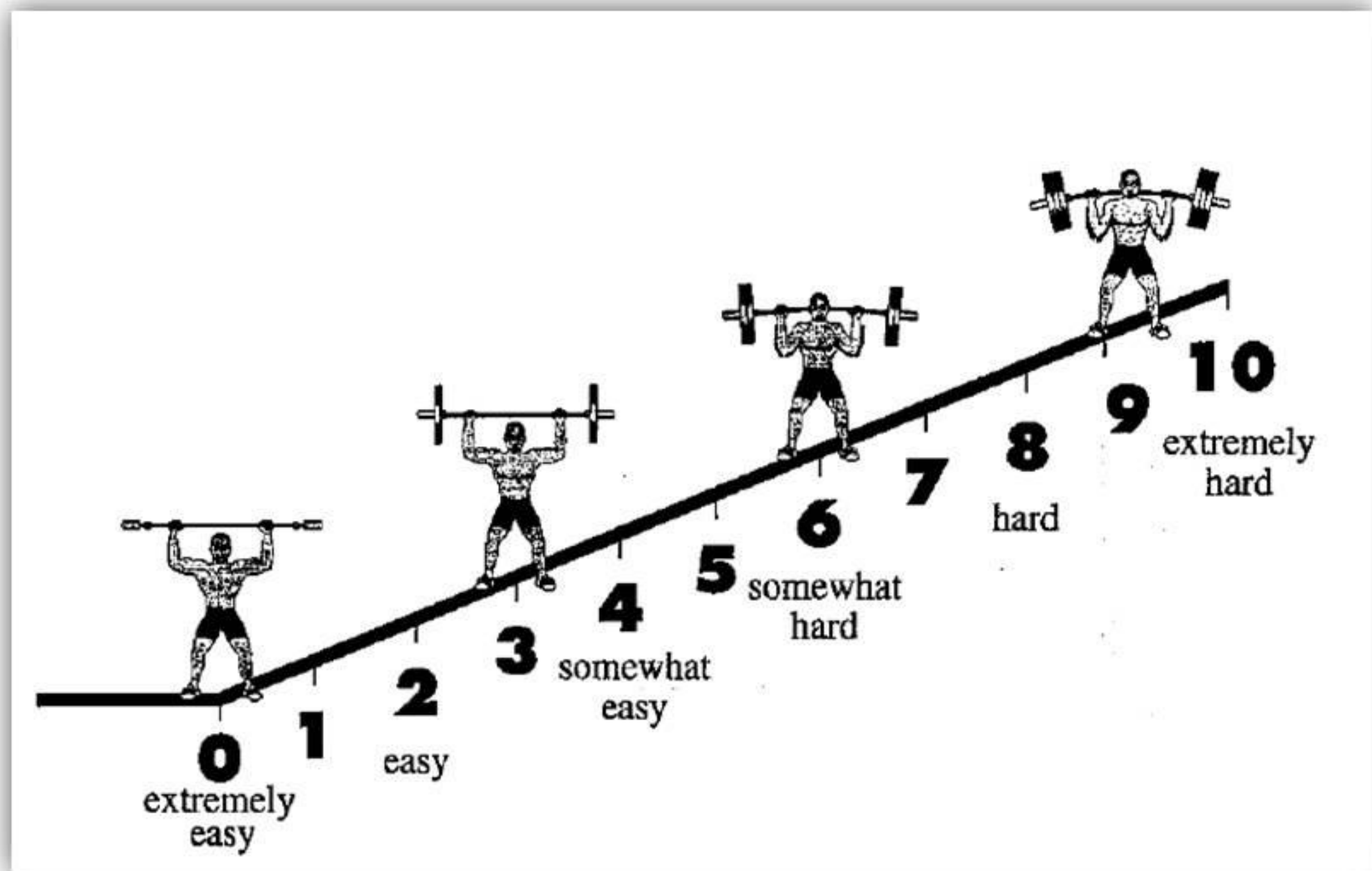
Strongly agree strongly disagree

12. I find that I am not accident prone

6 5 4 3 2 1

Strongly agree strongly disagree

Appendix 9 - OMNI-Resistance Exercise Scale with Weights



Appendix 10 - OMNI Resistance Exercise Scale with Thera-Band Resistance Bands

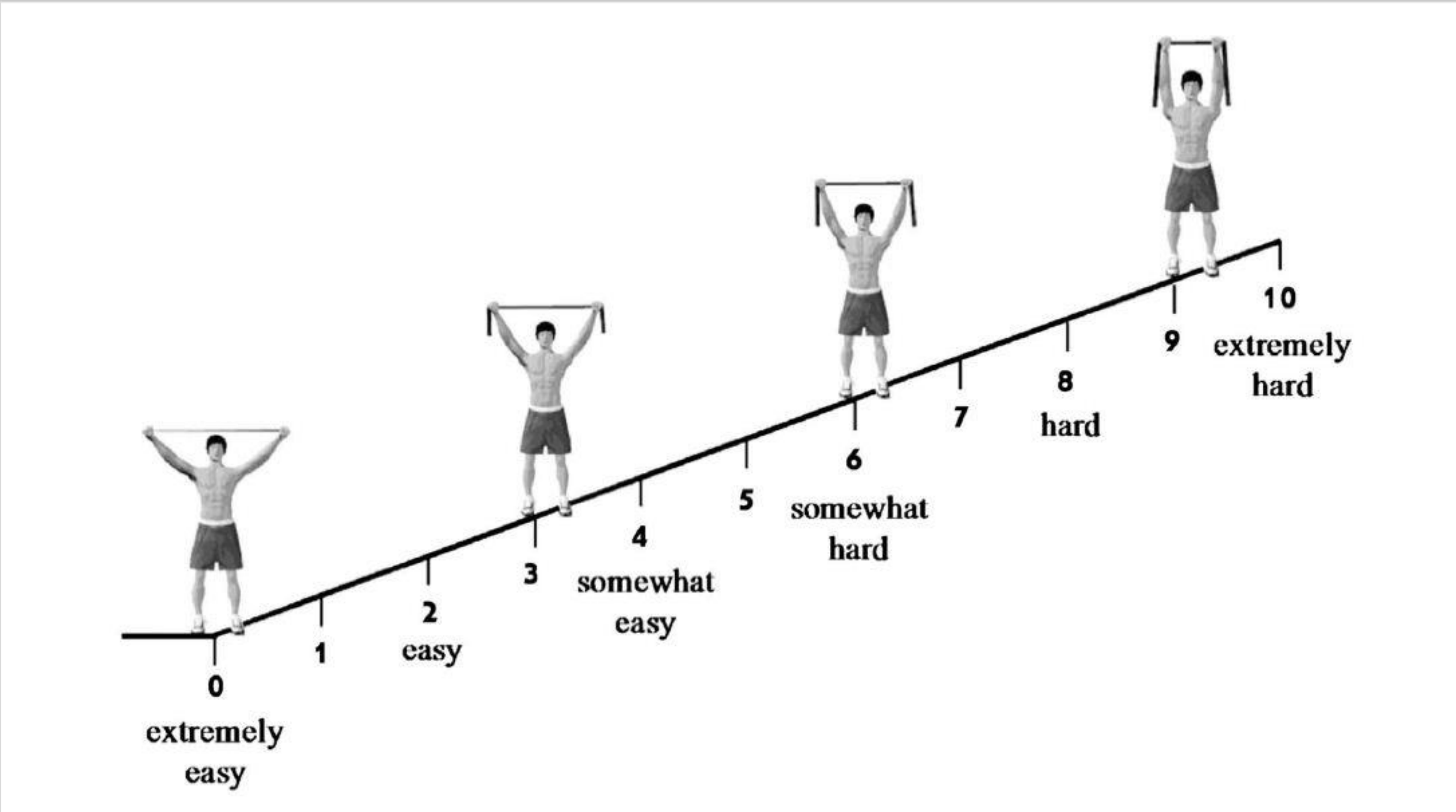


Figure 1. OMNI-Resistance Exercise Scale of perceived exertion with Thera-Band resistance bands.

Appendix 11 - Food Diary

Food Diary

Week: 1, 2, 3, 4, 5, 6

Meals	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Breakfast							
Lunch							
Dinner							
Snacks							

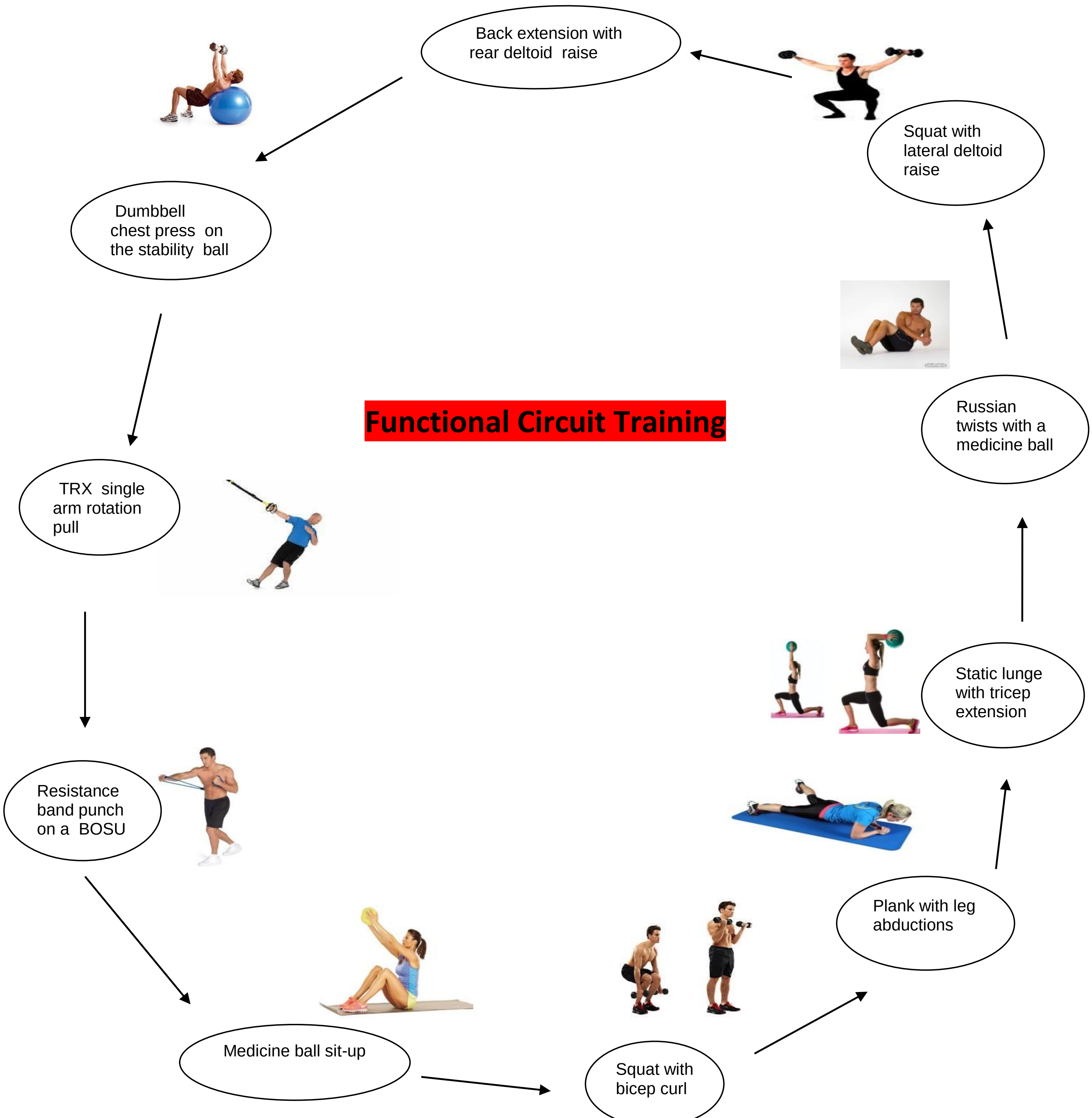
Appendix 12 - Physical Activity Diary

Physical Activity Diary

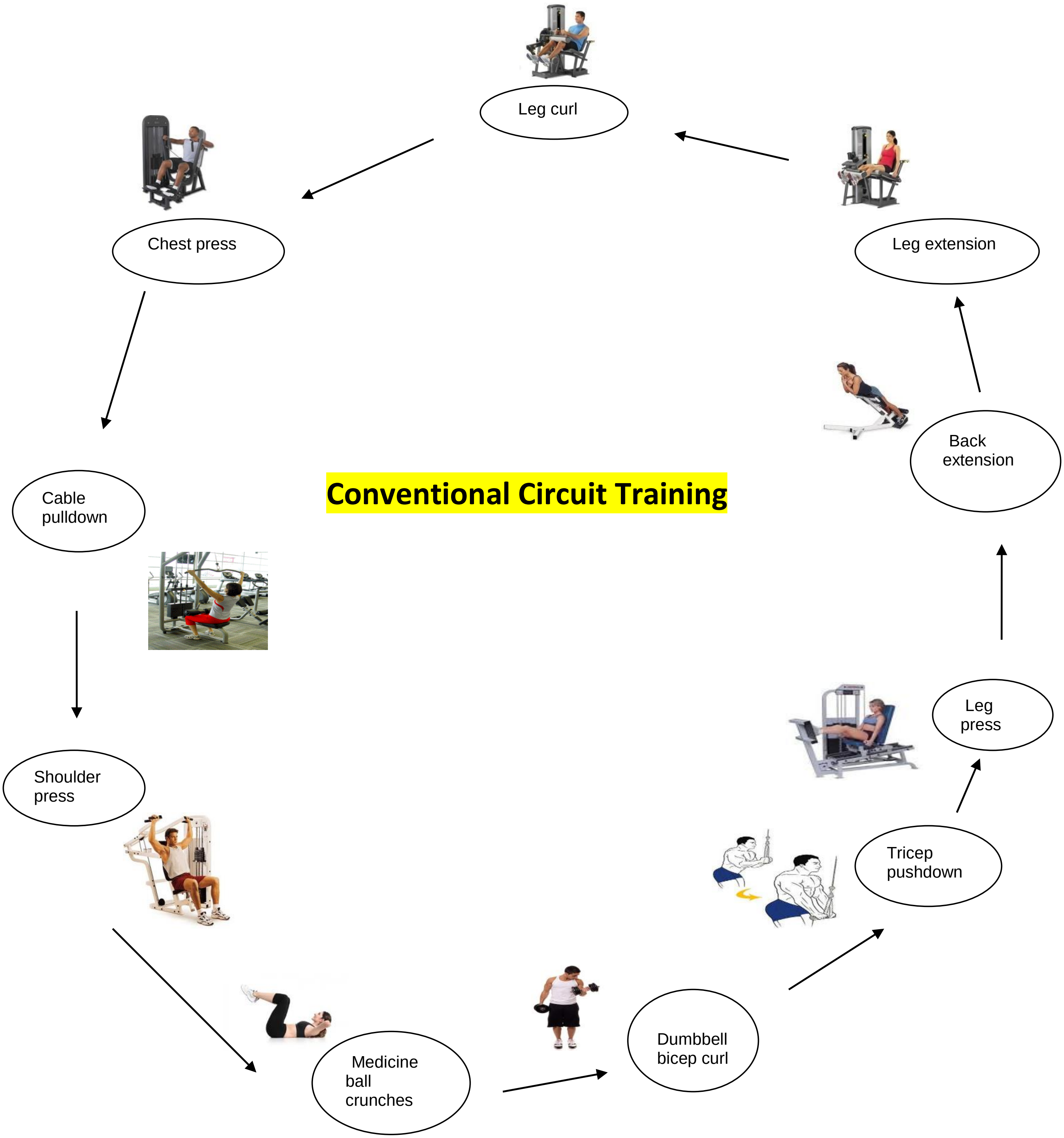
Week: 1, 2, 3, 4, 5, 6

Day	**Activity- Mode** (Running, cycling. speed walking, etc.)	**Duration** (minutes)	**Intensity** **0 1 2 3 4 5 6 7 8 9 10** Extremely easy ↔ Extremely hard
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

Appendix 13 - Functional Circuit Training



Appendix 14 - Conventional Circuit Training



Appendix 15 - Frequency of "Junk Food" Consumption per Week

* ID	Week 1 (number of times per week)	Week 2	Week 3	Week 4	Week 5	Week 6
1						
2	3	10	9	8	9	9
3	9	6	6	7	8	6
4	6	6	6	6	6	6
5	2	2	2	4	5	3
6	11	11	10	8	10	8
7	11	13	10	15	10	
8	16	12	11	12	12	1
9	6	6	6	6	6	6
10	8	13	10	12	10	3
11						
12	7	8	6	10	9	11
13	2	2	3	1	2	
14	11	15	8	8	11	
15						

* **ID**: Identification Number

"Junk Food": Pizza, burgers, fried chicken/fish/potatoes, Chinese/Indian/Thai takeaway, pastries, chips, sausage rolls, pies, ice cream, cakes, biscuits, chocolate, confectionary, jam, creamy dips, spirits, soft drinks, muffins, pop-corn, noodles, sandwiches, hot-dogs, toast (Smith et al., 2009; Arya & Mishra, 2013).

Appendix 16 - Qualitative Analysis of Physical Activity Diaries based on Mean Activity Intensity Levels

ID	* Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
1						
2	4.3	4.3	3.8	3.2	3.4	3.3
3	4.6	5.1	4.6	3.6	4.1	3.9
4	8.3	8.3	8.3	8.3	8.3	8.3
5	5.8	5.5	5.1	3.1	4.8	6
6	3	2.8	3	6	4	2.3
7	5	6	7	7.5	6	
8	7	6.5	7	8	7.5	
9						
10	4	2.8	2.8	2	3	3
11						
12	1	1.6	1.9	1.4	2.3	1.6
13		3.7		4		
14		3	3	3.5	3.5	
15						

* **Weeks 1-6:** Data were calculated as mean values of seven days intensity of activity